Cambridge Assessment International Education

Cambridge International AS & A Level

CHEMSITRY **9701/33**

Paper 3 Advanced Practical Skills 1 **May/June 2022**

MARK SCHEME

Maximum Mark: 40

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the May/June 2022 series for most Cambridge IGCSE, Cambridge International A and AS Level and Cambridge Pre-U components, and some Cambridge O Level components.

© UCLES 2022

PUBLISHED

Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently, e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

© UCLES 2022

GENERIC MARKING PRINCIPLE 5: Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).
GENERIC MARKING PRINCIPLE 6: Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Science-Specific Marking Principles

1	Examiners should consider the context and scientific use of any keywords when awarding marks. Although keywords may be present, marks should not be awarded if the keywords are used incorrectly.
2	The examiner should not choose between contradictory statements given in the same question part, and credit should not be awarded for any correct statement that is contradicted within the same question part. Wrong science that is irrelevant to the question should be ignored.
3	Although spellings do not have to be correct, spellings of syllabus terms must allow for clear and unambiguous separation from other syllabus terms with which they may be confused (e.g. ethane / ethene, glucagon / glycogen, refraction / reflection).
4	The error carried forward (ecf) principle should be applied, where appropriate. If an incorrect answer is subsequently used in a scientifically correct way, the candidate should be awarded these subsequent marking points. Further guidance will be included in the mark scheme where necessary and any exceptions to this general principle will be noted.
5	‘List rule’ guidance For questions that require ***n*** responses (e.g. State **two** reasons …): • The response should be read as continuous prose, even when numbered answer spaces are provided. • Any response marked *ignore* in the mark scheme should not count towards ***n***. • Incorrect responses should not be awarded credit but will still count towards ***n***. • Read the entire response to check for any responses that contradict those that would otherwise be credited. Credit should **not** be awarded for any responses that are contradicted within the rest of the response. Where two responses contradict one another, this should be treated as a single incorrect response. • Non-contradictory responses after the first ***n*** responses may be ignored even if they include incorrect science.

© UCLES 2022

6 Calculation specific guidance

Correct answers to calculations should be given full credit even if there is no working or incorrect working, **unless** the question states 'show your working'.

For questions in which the number of significant figures required is not stated, credit should be awarded for correct answers when rounded by the examiner to the number of significant figures given in the mark scheme. This may not apply to measured values.

For answers given in standard form (e.g. $a \times 10^n$) in which the convention of restricting the value of the coefficient (a) to a value between 1 and 10 is not followed, credit may still be awarded if the answer can be converted to the answer given in the mark scheme.

Unless a separate mark is given for a unit, a missing or incorrect unit will normally mean that the final calculation mark is not awarded. Exceptions to this general principle will be noted in the mark scheme.

7 Guidance for chemical equations

Multiples / fractions of coefficients used in chemical equations are acceptable unless stated otherwise in the mark scheme.

State symbols given in an equation should be ignored unless asked for in the question or stated otherwise in the mark scheme.

© UCLES 2022

Question	Answer	Marks
1(a)	**I** All the following data are recorded: • two burette readings **AND** titre for the rough titration • initial and final burette readings for two (or more) accurate titrations	**7**
	II Correct headings and units in the accurate titration table • initial / start **AND** (burette) reading/volume + unit • final / end **AND** (burette) reading/volume + unit • titre + unit **OR** volume / **FA 2 and** used / added + unit	
	III All accurate burette readings are recorded to the nearest 0.05 cm^3	
	IV The final accurate titre recorded is within 0.10 cm^3 of any other accurate titre	
	For assessment of accuracy marks, round all burette readings to the nearest 0.05 cm^3. Check and correct subtractions. Then select the 'best' titres using the hierarchy: • two (or more) accurate identical titres (ignoring any that are labelled 'rough'), *then* • two (or more) accurate titres within 0.05 cm^3, *then* • two (or more) accurate titres within 0.10 cm^3, *etc.* These best titres should be used to calculate the mean titre, expressed to nearest 0.01 cm^3. Write the Supervisor's [corrected] mean titre in a ring on each candidate script Calculate the difference (δ) between the candidate's mean titre and the supervisor's. Write the value of δ on each script. Award the accuracy marks as shown below.	
	Award **V** if $\delta \leqslant 0.50$ (cm^3) Award **VI** if $\delta \leqslant 0.30$ Award **VII** if $\delta \leqslant 0.20$	
1(b)	Correctly calculates the mean titre correct to 2 dp from accurate titres that are within 0.20 cm^3 total spread	**1**
1(c)(i)	Correctly calculates amount of NaOH used = $0.150 \times \frac{\textbf{(b)}}{1000}$ **AND** answer to 3 or 4 significant figures	**1**

Question	Answer	Marks
1(c)(ii)	Correctly calculates amount of H_3PO_4 in 25 cm^3 = $\frac{6.86}{40} \times \frac{1}{98.0}$ = 0.00175(0) = 1.75×10^{-3} mol	**1**
1(c)(iii)	Acid is diprotic **AND** reason using answers **(c)(i)** and **(c)(ii)** Explanation: mole ratio of ans **(c)(i)** : ans **(c)(ii)** = 2 : 1 (approx) **OR** calculation shown	**1**
1(c)(iv)	Equation follows from the proticity stated in **(c)(iii)** Expected equation: $H_3PO_4 + 2NaOH \rightarrow Na_2HPO_4 + 2H_2O$	**1**
1(d)(i)	Correct expression for % error = $\frac{100 \times 0.06}{25}$ (= 0.24%)	**1**
1(d)(ii)	Student is incorrect **AND** explanation given: burette error = 2 × 0.05 (which is >0.06 / so 0.40% > 0.24%)	**1**

Question	Answer	Marks
2(a)	**I** Unambiguous headings and units for four weighings and entered in the space provided: • (mass of) crucible, lid (empty) • (mass of) crucible, lid and **FA 4** (or 'contents before heating') • (mass of) crucible, lid and **FA 5** / residue / contents after first heating • (mass of) crucible, lid and **FA 5** / residue / contents after second heating Units: / g or (g) or gram(me)s or in grams	**5**
	II Readings are appropriately recorded: • all weighings recorded to same number of decimal places (two or more) • mass of **FA 4** is within the range 0.80–1.80 g *(from weighings)* • fourth weighing is within +0.02 and –0.05 g of third weighing	
	III Correct subtractions to give: • mass of **FA 4** • mass of **FA 5** • mass loss	
	For assessment of accuracy marks: calculate supervisor's mass ratio (to 2 d.p.) = $\frac{\text{mass } \mathbf{FA\ 4}}{\text{mass } \mathbf{FA\ 5\ (residue)}}$ Write this value in a ring on each script. Calculate the 25% and 10% ranges correct to 2 dp. Calculate the candidate's mass ratio (to 2 dp) = $\frac{\text{mass } \mathbf{FA\ 4}}{\text{mass } \mathbf{FA\ 5\ (residue)}}$ Award accuracy marks as shown below.	
	Award **IV** if δ is within 25% of supervisor **AND** ratio > 1.00 Award **V** if δ is within 10% of supervisor **AND** ratio > 1.00	
2(b)(i)	Correctly calculated amount of CO_2 = $\frac{\text{mass loss}}{44}$ mol **AND** answer to 2–4 significant figures	**1**

Question	Answer	Marks
2(b)(ii)	Correctly uses M_r of **FA 4** = $\frac{\text{mass of FA 4 used}}{\textbf{(b)(i)}}$ **AND** answer to 2–4 sf	**1**
2(b)(iii)	A_r of metal = **(b)(ii)** – 60 **AND** Group 2 metal correctly deduced from A_r *Be if A_r is in range 0 – 12.1: Mg for A_r 12.2 – 32.2: Ca for A_r 32.2 - 63.8: Sr for A_r 63.9 – 112.4: Ba for A_r 112.5 – 250* (Other metals forming white carbonates with formula MCO_3 are acceptable provided the A_r is close to the value given in the periodic table.)	**1**
2(c)	**M1**: student's mass loss is lower **AND** M_r H_2O < M_r CO_2 (or values given) **M2**: using Mg as example % loss from $Mg(OH)_2$ = $\left(\frac{18}{58.3}\right) \times 100$ % loss from $MgCO_3$ = $\left(\frac{44}{84.3}\right) \times 100$ (which is greater than % for $Mg(OH)_2$)	**2**
2(d)	**EITHER** **M1**: solid dissolves **OR** colourless solution formed **M2**: decomposition is complete **AND** reason: no gas / no CO_2 / no fizzing produced (when acid added) **OR** **M1**: effervescence (owtte) **OR** gas / CO_2 gives white ppt with limewater **M2**: decomposition is not complete **AND** reason: carbonate reacts / fizzes / gives out CO_2 with acid / oxide does not fizz with acid	**2**

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td colspan="3">FA 6 is $CuCl_2(aq)$; FA 7 is $FeCl_3(aq)$; FA 8 is $(NH_4)_2SO_4(s)$</td></tr>
<tr><td>3(a)(i)</td><td>Correct observations and no extra reagents used
<table>
<tr><th>test</th><th>FA 6</th><th>FA 7</th></tr>
<tr><td>KI</td><td>ppt
AND brown / yellow-brown / orange-brown / red-brown *
(colour of ppt need not be given but allow shades of white and the browns given above)</td><td>red-brown / brown solution
OR turns red-brown / brown *</td></tr>
<tr><td>then thio</td><td>brown colour fades / disappears
OR white / off-white / cream ppt
OR ppt dissolves (in excess thio) *
(Insoluble in excess is incorrect)
(If the colour of solution is given it must be colourless, pale yellow or pale brown.)</td><td>colourless solution (forms)
OR
(solution) turns colourless / decolourised *
(The formation of the initial purple colour of the thiosulfate complex or the final white / off-white ppt (on standing) are not part of this mark.)</td></tr>
<tr><td>Zn</td><td>solution becomes paler blue / colourless
OR brown / black / pink-brown / red-brown ppt / solid (formed) *</td><td>fizzing / bubbles / effervescence *
(gas) pops with lighted splint
OR (gas) burns with a pop*</td></tr>
<tr><td>$AgNO_3$</td><td>white ppt (formed) *</td><td>white / off-white / cream / pale yellow ppt (formed) *</td></tr>
<tr><td>NaOH</td><td>(pale) blue ppt
AND insoluble in excess *</td><td>rust / brown / orange-brown / red-brown ppt (which does not dissolve in excess) *</td></tr>
</table>
2 * = 1 mark</td><td>5</td></tr>
</table>

Question	Answer	Marks
3(a)(ii)	Any **one** of the following ionic equations with correct state symbols: • $Zn(s) + Cu^{2+}(aq) \rightarrow Cu(s) + Zn^{2+}(aq)$ • $Zn(s) + 2H^{+}(aq) \rightarrow H_2(g) + Zn^{2+}(aq)$ • $3Zn(s) + 2Fe^{3+}(aq) \rightarrow 2Fe^{2+}(aq) + 3Zn^{2+}(aq)$	**1**
3(b)(i)	Award any **two** of the following: • Sublimation occurs **OR** (white) solid condenses / reforms (on sides of tube) **OR** white smoke **OR** white fumes • Liquid / water forms **OR** frothing **OR** (liquid) condensation **OR** steam produced **OR** solid melts **OR** solid dissolves • (Moist red) litmus turns blue • Residue is colourless / white / off-white / light grey / cream (on cooling) **OR** no residue • (Gas / fumes) turn (blue) litmus red (Litmus tests must be mentioned in the right order to award both •)	**2**
3(b)(ii)	**M1** 'table' (2×2 min) with <u>headings:</u> 'test / experiment / reagents' **and** 'observations' (owtte) **AND** two (or more) reagents listed in the space **(Cation test)** **M2** Warm / heat with NaOH (and without A*l*) **M3** Gas / effervescence / NH_3 turns (red) litmus blue **(Anion test)** **M4** Add (aqueous) $BaCl_2$ / $Ba(NO_3)_2$ **AND** to a solution of **FA 8** **M5** White ppt (forms) **AND either** ppt is insoluble in (excess) HC*l* / HNO_3 **or FA 8** / mixture does not decolorise (acidified) potassium manganate(VII) / $KMnO_4$ **M6 FA 8** is $(NH_4)_2SO_4$	**6**